

What Is Claimed Is:

1. A method for manufacturing a piezoelectric material expressed by the formula ABO_3 , containing an element "a" as the element expressed by A above, and having a perovskite crystal structure, comprising:

a first step of producing an oxide containing an element "a'"; and

a second step of producing a piezoelectric material by subjecting the oxide produced in the first step to a hydrothermal processing using an aqueous solution containing the element "a",

wherein the amount of the element "a" contained in the piezoelectric material produced in the second step is increased over the amount of the element "a" contained in the oxide produced in the first step.

2. The method for manufacturing a piezoelectric material according to Claim 1,

wherein the element "a" used in the second step is an element not contained in the oxide produced in the first step.

3. The method for manufacturing a piezoelectric material according to Claim 1, wherein the oxide produced in the first step is a piezoelectric material expressed by the formula ABO_3 , containing an element "a'" as the element

expressed by A above, and having a perovskite crystal structure.

4. The method for manufacturing a piezoelectric material according to Claim 1,

wherein the oxide produced in the first step is a piezoelectric material expressed by the formula ABO_3 , containing an element "a" as the element expressed by A above, and having a perovskite crystal structure, and

the first step involves subjecting an oxide in an amorphous state to a hydrothermal processing using an aqueous solution containing the element "a", and crystallizing the oxide in the amorphous state.

5. The method for manufacturing a piezoelectric material according to Claim 1, wherein the oxide produced in the first step is an oxide in an amorphous state, and

the hydrothermal processing in the second step crystallizes the oxide produced in the first step.

6. The method for manufacturing a piezoelectric material according to Claim 5,

wherein the hydrothermal processing in the second step is conducted using an aqueous solution containing both the element "a" and the element "a'" or another element expressed by A.

7. The method for manufacturing a piezoelectric material according to Claim 6,

wherein the ratio in which the element "a" and the element "a'" or another element expressed by A are present in the aqueous solution is adjusted to between 2:8 and 4:6.

8. The method for manufacturing a piezoelectric material according to any of Claims 1 to 7,

wherein the aqueous solution containing the element "a" is an alkali aqueous solution of a compound expressed by the formula $a(OH)_n$ ($n = 1, 2, \text{ or } 3$).

9. The method for manufacturing a piezoelectric material according to Claim 4, 6, or 7,

wherein the aqueous solution containing the element "a'" is an alkali aqueous solution of a compound expressed by the formula $a'(OH)_n$ ($n = 1, 2, \text{ or } 3$).

10. The method for manufacturing a piezoelectric material according to any of Claims 1 to 7, wherein the element "a" is lead.

11. The method for manufacturing a piezoelectric material according to any of Claims 1 to 7,

wherein the element "a'" is one element selected from the group consisting of barium, strontium, lanthanum, and calcium.

12. The method for manufacturing a piezoelectric material according to any of Claims 1 to 7, wherein the element expressed by B is zirconium and/or titanium.

13. The method for manufacturing a piezoelectric material according to any of Claims 1 to 7, wherein the concentration of the aqueous solution used in the hydrothermal processing in the second step is between 0.05 M (mol/L) and 2.0 M (mol/L).

14. The method for manufacturing a piezoelectric material according to any of Claims 1 to 7, wherein the treatment temperature in the hydrothermal processing in the second step is between 120°C and 200°C.

15. The method for manufacturing a piezoelectric material according to any of Claims 1 to 7, wherein the treatment pressure in the hydrothermal processing in the second step is between 2 atmospheres and 20 atmospheres.

16. The method for manufacturing a piezoelectric material according to any of Claims 1 to 7, wherein the

treatment time in the hydrothermal processing in the second step is between 15 minutes and 120 minutes.

17. The method for manufacturing a piezoelectric material according to any of Claims 4 to 7, wherein the oxide in an amorphous state is produced by coating and pyrolyzing with a sol containing an organometal.

18. The method for manufacturing a piezoelectric material according to any of Claims 1 to 7,

wherein the piezoelectric material is composed of lead titanate (PbTiO_3), lead zirconate-titanate ($\text{Pb}(\text{Zr},\text{Ti})\text{O}_3$), lead zirconate (PbZrO_3), lead-lanthanum titanate ($(\text{Pb},\text{La})_2\text{TiO}_3$), lead-lanthanum zirconate-titanate ($(\text{Pb},\text{La})(\text{Zr},\text{Ti})\text{O}_3$), or lead zirconate-titanate magnesium-niobate ($\text{Pb}(\text{Zr},\text{Ti})(\text{Mg},\text{Nb})\text{O}_3$).

19. A method for manufacturing a piezoelectric element, comprising the steps of:

forming a lower electrode;

forming over the lower electrode a film of a piezoelectric material exhibiting piezoelectricity by the method for manufacturing a piezoelectric material according to any of Claims 1 to 7; and

forming an upper electrode over the piezoelectric material.

20. A method for manufacturing an ink jet recording head, comprising the steps of:

forming a diaphragm film over a substrate;
manufacturing a piezoelectric element over the diaphragm film by the method for manufacturing a piezoelectric element according to any of Claims 1 to 7; and

working the substrate and forming a pressurization chamber at a site capable of transmitting displacement of the diaphragm film produced by driving of the piezoelectric element.

21. The method for manufacturing a piezoelectric material according to Claim 3,

wherein the element "a" is barium, the element "a'" is lead, and the element expressed by B is titanium.

22. The method for manufacturing a piezoelectric material according to Claim 21,

wherein the oxide produced in the first step is lead titanate (PbTiO_3) composed of acicular crystals.

23. The method for manufacturing a piezoelectric material according to Claim 22,

wherein the first step produces the oxide by MOD.

24. The method for manufacturing a piezoelectric material according to Claim 22,

wherein the piezoelectric material produced in the second step is barium-lead titanate expressed by the chemical formula $(\text{Ba}_x\text{Pb}_{1-x})\text{TiO}_3$,

and x in this formula is within the range of $0 \text{ (at\%)} < x < 5 \text{ (at\%)}$.

25. A piezoelectric material expressed by the chemical formula $(\text{Ba,Pb})\text{TiO}_3$,

wherein the piezoelectric material is composed of acicular crystals, at a specific spacing there are dislocation layers in which lattice defects are present, and the spacing between adjacent dislocation layers is at least 10 nm.

26. The piezoelectric material according to Claim 25,

wherein the piezoelectric material is expressed by the chemical formula $(\text{Ba}_x\text{Pb}_{1-x})\text{TiO}_3$, and x in this formula is within the range of $0 \text{ (at\%)} < x < 5 \text{ (at\%)}$.

27. A piezoelectric element comprising the piezoelectric material according to Claim 25 or 26 and electrodes with which voltage can be applied to this piezoelectric material.

28. An ink jet recording head, wherein the piezoelectric element according to Claim 27 is provided as a piezoelectric actuator.

29. A printer, equipped with the ink jet recording head according to Claim 28 as printing means.